

municipal landfills. Placing fluorescent bulbs under this rule will "better protect public health and the environment from mercury contamination," said EPA administrator Carol M. Browner in a 28 June 1999 EPA press release.

Fluorescent lamps contain mercury, an essential compound for operation that generates ultraviolet rays that react with the bulb's phosphorous coating to



Lamps in the landfill. A new EPA rule will make it easier to recycle fluorescent bulbs, thus preventing disposal of many such mercury-containing lamps in landfills.

emit fluorescent light. Because fluorescent bulbs have been inconsistently disposed of, specific numbers on the amount discarded are unavailable. However, according to the EPA, mercury-containing bulbs account for 3.8% of all mercury now going to municipal landfills. Such bulbs continue to be a health and environmental concern. Mercury toxicity can cause impaired growth and development, reduced reproductive success, and death in humans. Mercury bioaccumulates most efficiently in the aquatic food chain, where it's converted into toxic methylmercury by bacteria. The primary pathway of exposure for humans and wildlife is by eating fish contaminated with mercury.

The EPA's primary objective in placing mercury-containing bulbs under the Universal Waste Rule is to minimize mercury emissions into the environment while encouraging recycling and proper disposal of fluorescent bulbs. The rule also encourages the manufacture of bulbs with lower mercury content. Items that fall under the category of universal waste include trash—such as batteries and thermostats—that is often thrown out by households and small businesses. Under

the Universal Waste Rule, consumers can avoid many of the previously more stringent regulatory requirements for storing, transporting, and collecting mercury-containing bulbs. For example, the rule extends the amount of time that companies can accumulate such materials on site and allows them to transport such waste via a common carrier instead of a hazardous waste transporter.

The new rule is aimed at large firms and government agencies, which account for the majority of disposed bulbs. The EPA claims that the rule is expected to save companies more than \$70 million per year in compliance costs. Currently, companies who use the mercury-containing bulbs in small quantities are not subject to RCRA waste management standards; if the company produces less than 5,000 kilograms of hazardous waste in one month, wastes may be sent to a municipal solid waste landfill. By placing fluorescent bulbs under the federal Universal Waste Rule, the EPA is encouraging states to regulate such bulbs, providing more consistency between federal and state regulations in the management of this kind of hazardous waste. The new rule takes effect 6 January 2000.

Botanists Plant Ideas

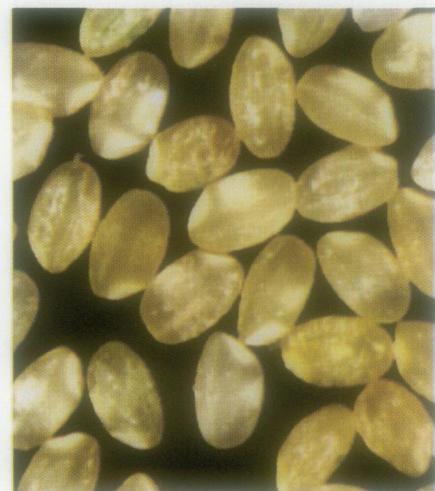
A recently completed project in bioengineering may help alleviate problems of iron and vitamin A deficiency around the world. Scientists at the Swiss Federal Institute of Technology's Institute of Plant Sciences in Zürich have modified rice grains—a staple of the diet of much of the world's population—to improve their content of vitamin A and iron. The results of this project were reported at the meeting of the 16th International Botanical Congress, held in August in St. Louis, Missouri. The congress, held once every six years, brings researchers together to present new knowledge of the intricate relationship between plants and humans. This year's meeting shed new light on topics that included plant bioengineering, global bioprospecting, and mapping the plant genome.

Rice grains normally are notoriously deficient in iron and vitamin A, said Ingo Potrykus, a professor of plant biology at

the Institute of Plant Sciences. Because rice is the staple food in many developing countries, the lack of these nutrients contributes heavily to iron and vitamin A deficiency in human populations, which can lead to anemia, impaired intellectual development, and immune system dysfunction. About 400 million people are deficient in vitamin A and an estimated 5 million have become blind as a result, according to Potrykus. An even larger number are iron-deficient.

Potrykus and his colleagues have produced beta-carotene (which converts to vitamin A) in rice grains by inserting two genes from the daffodil (*Narcissus pseudonarcissus*) and one from the bacterium *Erwinia uredovora* into the rice's genetic makeup. The resulting rice grains meet requirements for vitamin A in a typical Asian diet. To increase the bioavailability of iron in the rice grain, Potrykus's team added a ferritin gene from the green bean (*Phaseolus vulgaris*) and a heat-stable enzyme phytase from the fungus *Aspergillus fumigatus* to reduce the inhibition of iron absorption. Also, a gene for cysteine-rich protein was added to enhance iron resorption. If the modified rice is proven to have no adverse environmental and human health effects, there are plans to distribute it free of charge through the International Rice Research Institute of Los Baños, the Philippines, and national agricultural research centers.

While Potrykus's group is concerned with distributing plant products to the world, other research is focused on locating and harvesting medically valuable plant materials from around the world. In West Africa, traditional healers have for many centuries used the fruit and seeds of the



The rice remedy. A new strain of rice that has been genetically engineered to contain loads of vitamin A and aid in iron absorption will help fight dietary deficiencies in people around the world.

I. Potrykus, P. Bayer

Garcinia kola tree, known as "bitter kola," to treat infectious diseases. This treatment has no apparent side effects. *In vitro* tests of the plant identified 46 biochemical principles that appear to kill bacteria and viruses, including the deadly Ebola virus, the cause of fatal hemorrhagic fever. "The same forest that yields the dreaded Ebola virus could be a source of the cure," said Maurice Iwu, executive director of the non-governmental Bioresources Development and Conservation Programme in Silver Spring, Maryland. The program studies sustainable uses of tropical forests as alternatives to deforestation and provides management and technical support to development programs in tropical countries.

In global bioprospecting, however, identifying a *G. kola* or certain other medicine-containing species "would be considered lucky 'hits,'" said James Miller, associate curator of the Missouri Botanical Garden in St. Louis. "Normally, it is a slow, plodding process. The payoff could take 10–15 years to realize, from finding promising compounds in a plant to bringing a medicine to market," he estimated. Miller predicted that 1 prospect in 1,000 may contain a novel bioactive compound. Of those, perhaps 1 in 10 or even fewer may lead, directly or indirectly, to new drugs. The numbers, he said, may be a bit more optimistic for dietary supplements.

Other research presented at the congress concerned mapping the plant genome. "This story is not yet finished," said Christopher Somerville, the Stanford University-based director of the Department of Plant Biology of the Carnegie Institute of Washington, referring to a large international project that got underway in earnest in 1989 with the task of mapping and sequencing the genes of *Arabidopsis thaliana*, a plant of the mustard family that has become the white rat of plant researchers. *Arabidopsis* was chosen because its genome, consisting of about 23,000 genes, is only lightly masked by "junk" DNA (DNA that does not code genes).

As of July 1999, 80 million base pairs of an estimated total of 120 million had been sequenced, and completion of the project is expected in December 2000. At the completion of the project, *Arabidopsis* will be the only plant for which complete structural information is available for all of the genes. Plans are being made for a second phase of the mapping project in which the function of all 23,000 genes will be experimentally determined by 2010.



Making Peace with the Environment

After being bombarded for so long with images of Balkan republics at war, it may be overlooked that before the first NATO shell fell in Kosovo, Central and Eastern Europe (CEE) was a land of tremendous natural resources and unique wildlife. Part of this territory has been designated one of Europe's six centers of biodiversity. It is home to 68% of Europe's mammal species, 74% of its bird species, 51% of its fish species, and 39% of European vascular plants. In addition, CEE also contains important freshwater aquifers and Europe's longest river, the Danube.

In an effort to protect these resources and provide a regionwide forum for addressing environmental problems, the Regional Environmental Center (REC) for Central and Eastern Europe was established in 1990. The REC Web site is located at <http://www.rec.org/>. Programs have been conceived to address problems from decaying nuclear reactors to untreated sewage that flows into the Danube. The REC has also found itself in the new role of estimating the environmental impact of the war in Yugoslavia.

On its home page, an Environmental News heading links visitors to the REC's newest reports, including one titled *Assessment of the Environmental Impact of Military Activity During the Yugoslavia Conflict* which brings to light the environmental health hazards created through years of ethnic conflict and

78 days of NATO bombing. The REC report states that more than 1,000 metric tons of toxic ethylene dichloride leaked into the Danube during air strikes. Elsewhere on the site, the REC reports that more than 150 tons



of the toxic PCB pyralene was released from transformer stations as a result of NATO bombing. Just one liter of pyralene can pollute up to a billion liters of water. Other attacks on Serbian petrochemical industries have spilled large amounts of hydrochloric acid, chlorine, mercury, and other pollutants into the Danube River just upstream from important Romanian reservoirs.

The conflict in Yugoslavia has also taken its toll on many of the environmental groups and initiatives that were started in the region before the war. The REC is seeking to unify the people of the Balkans under the banner of a civil environmental movement. Details of the this initiative are found under the Environmental News link.

This link also contains *The Bulletin*, the REC's free online magazine. Quarterly issues of *The Bulletin* contain descriptions of REC programs in non-technical language and news on everything from ecotourism to upcoming environmental conferences. The summer 1999 issue is largely dedicated to the war in Kosovo.

Information on other REC activities can be found under the REC Programs link. The Business & Environment Program helps companies reduce pollution and encourages better communication between businesses and government, while the Sofia Initiatives are an effort by environmental leaders in CEE to identify the most urgent issues. Under the Japan Special Fund link, the Japanese government's \$2.7 million dollar effort to help remediate CEE sites is described. In one such project, new waste disposal processes are being developed for heavy metal pollution that was removed from around former leather factories in Siauliai, Lithuania, that had operated with almost no pollution controls.

The site also contains a Grants Program as well as online publications including policy papers, annual reports, and press releases.